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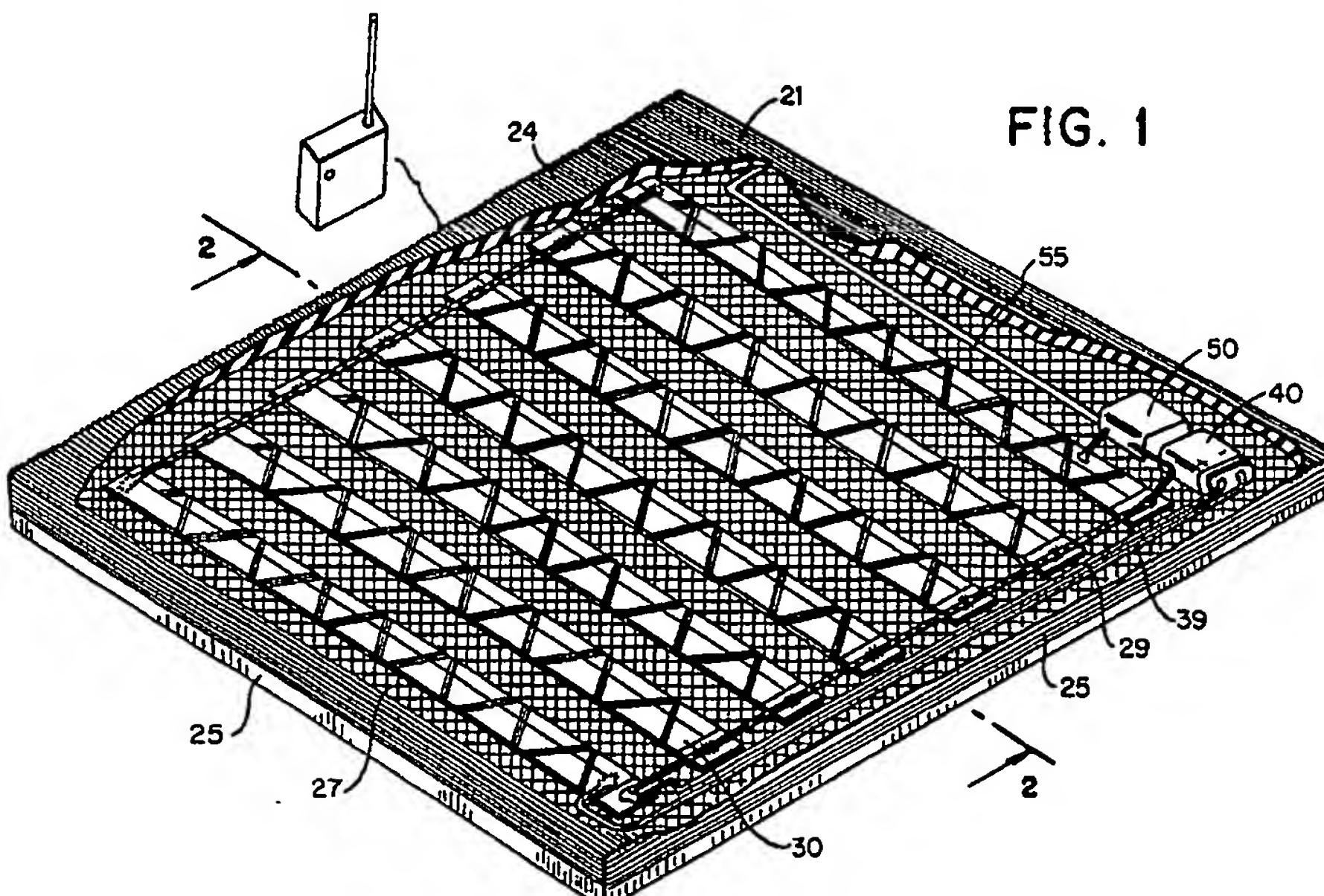
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⑯ Press-at-any-point switching device.

⑯ A press-at-any-point switching device which comprises at least one switching element and a signal transmitter for transmitting a signal to a signal receiver which is operatively coupled to a conventional control unit such as a switch on an electric

motor. Since the switching element of the present invention comprises a signal transmitter, there is no need for cumbersome and possibly dangerous electrical conduits which directly couple the switching element with the desired control unit.



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The present invention is directed to a press-at-any-point switching device; and more particularly, to a press-at-any-point switching device which comprises an electromagnetic wave generator and does not require direct coupling to a power source or the unit which is actuated.

### Background of the Invention

Press-at-any-point switches have been designed for a wide variety of applications. They have been utilized as floor mats, in automobile seat cushions, on elongated surfaces of potentially dangerous, heavy moving objects, and in other applications where the use of a button or other form of "single-point switch", such as a type used for a conventional doorbell, would not be suitable. Conventional press-at-any-point switches are typically located on or partially recessed within a surface which then defines an actuation zone. When pressure is applied to or in the case of a normally closed switch, removed from the actuation zone, a signal is relayed to a control mechanism, such as a motor. These conventional switches are typically directly coupled to the control mechanism via electrically conductive leads, i.e. wires, or some other form of continuous conduit through which a signal is transmitted.

In certain applications, the installation of a press-at-any-point switch, though highly desirable in a specific actuation zone, can be prohibitively expensive and can create other hazards. For example, in certain industrial applications, the preferred actuation zone is on the surface of the floor in a warehouse or manufacturing facility. The use of conventional press-at-any-point switches at these locations results in the presence of exposed electrical conduits which thereby create an undesirable obstruction to workers and machinery, or necessitates the expense of installing the electrical conduits in the flooring. In the latter case, if it becomes desirable to relocate the actuation zone, it has been necessary with conventional press-at-any-point switches to cut a new trench in the concrete flooring for the relocation of the necessary electrical conduits. This procedure is expensive, very time consuming, and also creates the danger that a worker will be injured during the relocation.

Furthermore, in certain applications it has been desirable to locate the actuation zone of a press-at-any-point switch outside the protective walls of a facility but permanent placement at an exterior location is not feasible in light of the risks of vandalism during time periods in which the facility is closed.

It is, therefore, desirable to provide a press-at-any-point switching device which is readily movable from one actuation zone to another without

incurring the expense, delay and other risks inherent in conventional relocation procedures. It is further desirable to provide a press-at-any-point switch which is sufficiently durable to withstand the physical and chemical abuse of industrial areas while providing ease in relocation from one actuation zone to another.

### Summary of the Invention

The present invention is directed to a press-at-any-point switching device which comprises a switching element with a power source and an electromagnetic wave generator such as a radio transmitter. The generated wave is designed to be transmitted to a remote signal receiver which is coupled to a conventional control unit such as a switch for an electric motor. Since the switching element of the present invention comprises a signal generator, there is no need for cumbersome and possibly dangerous signal conduits, e.g. electrical cables, which directly couple the press-at-any-point switching device with the desired control unit. Embodiments of the switching device of the present invention may be readily transported between different actuation zones without the expense, delay and potential danger inherent in the relocation of the electrical conduits of conventional press-at-any-point switching devices described above.

### Brief Descriptions of the Drawings

Figure 1 is a cross-sectional view of one embodiment of the present invention with sections removed.

Figure 2 is a cross-sectional view of the switching device shown in Figure 1 along lines 2-2.

Figure 3 is a top, perspective view of a set of contacts shown in Figure 1.

Figure 4 is perspective end-view of the press-at-any-point contacts shown in Figure 3.

Figure 5 is a perspective view of an alternative embodiment of the present invention with sections removed.

Figure 6 is a cross-sectional view taken along lines 6-6 of Figure 5.

Figure 7 is a partial, bottom perspective view of a corner of the switching device illustrated in Figure 5 showing a battery access door.

Figure 8 is a cross-sectional view of another embodiment of the present invention taken from a perspective similar to that of Figure 6.

Figure 9 is a perspective view, with sections removed, of still another embodiment of the present invention.

### Detailed Description

As used herein, the term "press-at-any-point" is meant to include switching elements which have an expanded actuation zone and which can be actuated by the application of or the removal of pressure at substantially any point along the actuation zone which essentially comprises one surface of the switch. In conformance with its usage in the art, this term is meant to exclude conventional contact switches such as those typically used for doorbells wherein the actuation of a device requires the application of pressure within a small, very specific area, such as the pushing of a button.

According to several embodiments of the present invention, the press-at-any-point switching element is in the form of a floor mat as illustrated in Figures 1 to 8. In one preferred embodiment of the present invention illustrated in Figures 5-8, the switching element is in the form of a protected floor mat. In accordance with an alternative embodiment, the switching element is in the form of a elongated edge switch for use on a elongated surface such as the edge of a moving object.

With reference to Figure 1 which illustrates a floor mat embodiment of the present invention with sections removed, switching device 10 comprises a protective outer casing having a top cover 21, bottom cover 27 and side walls 25. The outer casing is preferably formed of a wear-resistant moisture-resistant material such as a rubber elastomer, polyvinyl chloride, or polyurethane. The outer casing is also preferably impermeable to dirt and other materials which may adversely affect the operation of the switching device. Top layer 21, as well as all other layers utilized in mat 10, have at least a slight degree of flexibility which will allow the entire protective mat 10 to conform to floors or other mounting areas which are not perfectly flat. For example, it is preferable that the materials utilized in a mat having dimensions of 4 ft. X 4 ft. X 1 inch allow the mat to be readily flexed at least about 5° and preferably at least about 20° without adversely affecting the operation of the mat, where the angle is defined as the angle between a flat floor on which one end of the mat is placed and a tangent drawn along the opposing bottom surface of the mat. Of course, it will be appreciated by those skilled in the art that the angle of flexibility will depend, in part, upon the dimensions of the mat. Additionally, mat 10 is advantageously sufficiently flexible so that protective mat 10 can be placed over objects in the work area, such as a heavy utility electrical cord, without causing continuous actuation of the switches. Top layer 21 is formed of any material which will withstand the environment in which the protective mat 10 will be used. For example, it will be appreciated by those skilled in the art that certain materials will have greater resistance to corrosion by specific chemi-

cals than other materials which might otherwise be suitable.

One suitable material for the outer casing is KOROSEAL manufactured by the Koroseal and Rubber Matting Products Company of Akron, Ohio, a division of R.J.F. International Corp. This particular elastomer has been found to have a high resistance to wear, puncture and cutting. Koroseal is also relatively easy to work with and seal along its edges using sealing methods known in the art, for example, heat sealing.

As shown in Figure 1, top layer 21 may also comprise ribs 24 in order to provide skid resistance for people stepping on the mat. Ribs 24 also enhance the drainage of liquids which may fall onto the mat and thereby increase the overall life of the mat. While the thickness of top layer 21 may vary for the particular applications in which protective mat 10 will be used, it has been found that the preferred thickness of upper layer 21 is at least about 1/16 inch and is more preferably about 3/16 inch including the top ribs.

As shown in Figure 2, the casing may be formed of two separate pieces having cut out portions which receive the operative switching elements or, in a simpler version, may simply comprise two substantially laminar sheets with sufficient overlap at the edges to permit the sealing of the sheets. Those skilled in the art will appreciate that various methods of sealing the different portions of the casing may be utilized. For example, R-F heat sealing may be utilized when polyurethane or polyvinyl chloride materials are used since R-F energy provides durable seals which are relatively easy to form.

The interior side of top layer 21 may advantageously be provided with a plurality of ridges 22 extending the width of the mat and disposed perpendicularly to the longitudinal axes of the switching elements. Ridges 22 are designed to concentrate the force applied to top layer 21 to specific points on the contact elements 30.

The operative elements of the switching device include at least one and preferably a plurality of contact members 30, a power source 40, and an electromagnetic wave generator 50 having an antenna 55.

The electrical contacts may take any of various forms known in the art wherein the application of, or removal of, pressure from any point in the desired actuation zone establishes or breaks an electrical communication thereby.

One type of electrical pressure-actuated switch which is suitable for many industrial applications is shown in Figures 1-4 wherein electrical pressure-actuated switches 30 comprises electrical contacts 31 and 32 separated by insulating material 33. In order to facilitate construction, insulating material

may be formed in the shape of a strip having grooves 34 on both sides as shown in Figure 4. In this manner, one contact strip 32 may be disposed below the insulating grooves 34 while the other contact strip 31 may be disposed above the insulating groove 34. A non-conductive filament 35 is preferably wrapped around the electrical pressure-actuated switch 30 in order to hold the elements of the switch 30 together. Switches 30 may be connected in parallel, as shown in Figure 1, or in series via electrically conductive wires. As shown in Figure 1, pressure-actuated electrical switches 30 are connected to power source 40 and signal generator 50 via electrically-conductive conduits 39. It will be appreciated by those skilled in the art that other types of pressure-actuated electrical switches may be utilized without departing from the scope of the present invention.

For example, one or more normally-closed pressure-actuated, press-at-any-point switches such as the types disclosed in co-pending U.S. patent application 472,710 filed January 31, 1990, which is hereby incorporated by reference, may be used.

The desired spacing of the pressure-actuated switches will depend upon the specific application to which the protective mat will be used. A spacing of about 1 1/4 to about 5 inches from the center of one electrical switch to another is acceptable for many industrial applications.

Those skilled in that art will appreciate that signal generator 50 may be designed to generate an electromagnetic wave in response to a signal initiated at pressure-actuated switching elements. The signal is transmitted via antenna 55 to a remote signal receiver. Signal generator 50 may take several forms including any type of radio wave oscillator, an infra-red wave generator or a microwave generator. If a radio-wave generator is used, the present invention is not limited to specific frequencies or modulations.

Another embodiment of the present invention comprises a puncture-resistant protective layer wherein the switching elements are preferably isolated from both the environment and the puncture-resistant member. The preferred form of this embodiment comprises an upper moisture-resistant layer, a puncture-resistant and/or deformation-resistant protective layer disposed below the top layer, a bladder disposed below the protective layer and preferably attached to the upper layer so that the protective layer is isolated from the environment, and a switching chamber defined by the lower surface of the bladder and a lower outer surface. In accordance with this embodiment of the present invention, the switching element is protected from harmful matter such as moisture, dirt, or corrosive chemicals which may be present in the work area

near the protective mat even if the mat is subject to a blow from a sharp object which punctures the top outer layer.

According to the embodiment of the present invention illustrated in Figs. 5-8, disposed below top layer 110 is a puncture-resistant, and preferably deformation-resistant protective layer 120 which disperses forces applied to the mat. High, point-of-impact forces applied by sharp tools or the like, are dispersed over relatively wide areas in order to protect the portion of mat 100 disposed below protective layer 120 from puncture. As used herein, the term "deformation" is used to mean permanent deformation, i.e., a change in the shape of an object upon the application of a force wherein the object does not return to the configuration it had before the application of the force. As mentioned above, protective layer 120 has sufficient flexibility to enable bending of the entire protective mat 100 when the mat is not placed on a perfectly level surface. Protective layer 120 must have a sufficient degree of flexibility so that if protective mat 10 is placed on an uneven surface or a surface containing a ridge, for example, a concrete floor having a heavy electrical cord which runs under mat 100, protective layer 120 permits the entire mat 100 to bend without continuously actuating the pressure-actuated element 160. Protective layer 120 must also have sufficient resistance to permanent deformation such that if an object is dropped on protective mat 100, though the object may puncture top layer 110 and instantaneously deform protective layer 120, protective layer 120 will not stay in such deformed position so as to continuously actuate a pressure-actuated switching element.

One method of measuring the suitability of a material or combination of materials for use as protective layer 120 is to measure the distance that a dent or groove will protrude from the bottom surface of protective layer 120 after the application of an impact by a dart weighing about 2 1/2 pounds, with a point having a diameter of about 0.10 inches which is dropped from a still position approximately 8 feet above the mat. In order to be considered "deformation-resistant" in accordance with the present invention, the permanent deformation of a protective layer having a thickness of about 1/4 inch subject to the preceding "Dart Test" will preferably not exceed about 0.050 inches and is most preferably less than about 0.025 inches.

As used herein, the term "puncture-resistant" means that the protective layer will not be punctured, i.e. such that a hole passes entirely through the protective layer, when the layer is subjected to the "Dart Test" referenced above but modified such that the dart is dropped from a height of about 3 feet. It will be appreciated by those skilled

in the art that light gauge metals, such as 1/16 inch thick spring steel, are not "puncture-resistant" as that term is used herein.

While not necessary to the practice of the present invention, as shown in Figure 1, protective layer 120 may be advantageously sealed between top layer 110 and a bladder layer 140.

The material or combination of materials used in the construction of protective layer 120 are designed to disperse a blow of a sharp object which may come in contact with protective mat 10. Protective layer 120 may be formed of a single material such as one or more layers of a high impact-resistant polycarbonate e.g. LEXAN/LEXGUARD™ made by General Electric, or may be formed from layers of different materials such as a high-impact resistant polycarbonate with a middle-layer of reinforcing material such as Kevlar.

In order to spread the force of an impact over as wide an area as possible, it is preferable to have the bottom or non-impact side of protective layer 120 to be generally smooth.

Disposed below protective layer 120 is a hermetically-sealed switching chamber 160, shown in Figure 6, defined by flexible, moisture-resistant bladder layer 140 and flexible, moisture-resistant bottom layer 180.

The top 141 of bladder layer 140 is preferably substantially smooth in order to receive an impact from protective layer 120 over as wide of an area as possible. The bottom surface 142 of protective layer 140 preferably comprises a number of ribs 143 which extend substantially from one end of switching chamber 160 to the other end. The advantages provided by ribs 143 are the same as those provided by ribs 22 of mat 10 described above.

Bottom layer 180 has a top surface 181 and a bottom surface 182. As shown in Figure 6, bottom surface 182 of bottom layer 180 is advantageously provided with ribs 183 which will allow water and other fluids to drain below protective mat 100. Therefore, if protective mat 100 is intended for use in an area subject to liquid spills, protective mat 100 will not impede the drainage of the spilled liquid into an already existing drain nor will it cause fluids which might shorten the useful life of protective mat 100 to collect next to protective mat 100.

As illustrated in Figure 5, protective mat 100 also comprises a power source 190 and a signal generator 193 having an antenna 195. The operation and actuation of a signal may be the same as described above with reference to mat 10.

Figure 8 illustrates an alternative embodiment of a protective mat of the present invention wherein a plurality of protective layers 220, 221 are utilized in order to provide protection to the operative switching elements.

Figure 7 illustrates a battery access door 99 which may be provided to give access to the power source, as well as the signal generator. Depending upon the intended use of the switching device, the battery access door 99 may be sealed with a replaceable, moisture-resistant sealer such as silicone.

It will also be appreciated that, in accordance with the present invention, a switching chamber may be divided into a number of switching zones for several reasons. In certain applications, it may be desirable to have one portion of the switching element provide a signal to one control device while another portion of the switching chamber actuates another device. In some instances, it may also be desirable to provide a corresponding plurality of protective layers (not shown) which each extend over only a portion of a bladder layer, instead of a single protective layer 120 as shown in Figure 5. As an alternative, several isolated switching chambers can be provided.

As shown above in the embodiment of the present invention disclosed in Figures 1-4, if the pressure-actuated device comprises a plurality of electrical pressure-actuated switches 130, the switches 130 are preferably arranged perpendicular to the ribs 143 of bladder layer 140. In this manner, the force applied by each rib 143 at the point of contact between rib 143 and pressure-actuated electrical switch 130 is more concentrated than if the ribs 143 extended parallel to switches 130. It will be appreciated by those skilled in the art, that the actuation of switches 130 only requires contact at a single point along the top or bottom of the switches 130, as opposed to a complete contact along the entire length of the switch 130.

Those skilled in the art will also appreciate that alternative pressure-actuated switching devices may be utilized in place of the illustrated electrically-conductive contacts. For example, a pneumatically-operated switching device could be coupled with a signal generator.

The present invention may be practiced with a pressure-actuated switching device taking many shapes. For example, a single pressure-actuated switching element such as switch 300 illustrated in Figure 9 may be electrically connected with an electromagnetic wave generator 350 and a power source 340. Such a switch and/or the signal generator may be enclosed within a flexible protective housing 320. The press at any point switch 300 is suitable for placement on the edge of a movable object such as the bottom of a garage door or another piece of equipment any may be fastened to the desired actuation surface if desired.

## Claims

1. A switching device comprising:  
a press-at-any-point switching element comprising:  
a first electrically-conductive contact element;  
a second contact element normally movably disposed in spaced relation with said first contact element;  
a power source; and  
an electromagnetic wave generator in electrical communication with at least one of said contacts and responsive to electrical communication between said contacts such that electrical communication between said contact elements results in the generation of electromagnetic waves; and  
signal receiving means for detecting said electromagnetic waves.
2. A switching device according to claim 1 wherein said first contact element and said second contact element are separated by at least one electrical insulator.
3. A switching device according to claim 1 wherein said power source is a battery.
4. A switching device according to claim 1 wherein said electromagnetic wave generator is a radio-signal generator.
5. A switching device according to claim 1 wherein said switching element is substantially enclosed within a water-resistant housing.
6. A switching device according to claim 5 wherein said switching element further comprises at least one puncture-resistant layer disposed over said housing.
7. A switching device according to claim 6 wherein said puncture-resistant layer comprises a polycarbonate.
8. A switching device according to claim 6 wherein said puncture-resistant layer comprises a plurality of puncture-resistant layers.
9. A press-at-any-point switching device comprising:  
a first surface comprising:  
an actuation zone;  
means for detecting a change in pressure at any point on said actuation zone;  
a power source; and  
an electromagnetic wave generator operatively coupled with said detecting means such that an electromagnetic wave is generated in response to the detection of a change in pressure on said actuation zone.
10. A press-at-any-point switching device according to claim 9 wherein said detecting means comprises a first electrically-conductive contact and a second electrically-conductive contact normally movably disposed in spaced relation with said first contact.
11. A press-at-any-point switching device according to claim 10 wherein said detecting means detects the application of pressure to said actuation zone.
12. A press-at-any-point switching device according to claim 10 wherein said detecting means detects the removal of pressure from said actuation zone.
13. A press-at-any-point switching device according to claim 9 further comprising a puncture-resistant protective layer disposed over said actuation zone.
14. A press-at-any-point switching device according to claim 12 wherein said protective-layer is deformation resistant.
15. A mat switch comprising:  
a flexible top layer wherein said top layer is moisture-resistant;  
a flexible bladder layer;  
a puncture-resistant, flexible, polycarbonate protective layer hermetically sealed between said top layer and said bladder layer;  
a flexible, moisture-resistant bottom layer;  
a plurality of pressure-actuated electrical switches and an electromagnetic wave generator hermetically sealed between said bladder layer and said bottom layer such that an electromagnetic wave is generated in response to a signal from said pressure-actuated switches
16. A protective mat according to Claim 15 wherein said top layer comprises a rubber elastomer.
17. A protective mat according to Claim 15 wherein said bladder layer comprises a rubber elastomer.
18. A protective mat according to Claim 15 wherein said bottom layer comprises a rubber elastomer.
19. A protective mat according to Claim 15 wherein said protective layer is deformation-

resistant.

20. A protective mat according to Claim 1 wherein said protective layer comprises a laminate of a plurality of materials. 5

21. A mat switch comprising:  
a water-tight switching chamber;  
a pressure-actuated switching device and an electromagnetic-wave generator disposed at least partially within said switching chamber;  
a puncture-resistant protective layer disposed above said switching chamber. 10

22. A protective mat according to Claim 21 wherein said protective layer is attached to said switching chamber. 15

23. A protective mat according to Claim 21 wherein said protective layer is deformation-resistant. 20

24. A protective mat according to Claim 21 wherein said protective layer comprises a laminate of a plurality of materials. 25

25. A press-at-any-point switch comprising:  
a first electrically-conductive contact;  
a second electrically-conductive contact movably disposed proximate said first electrically-conductive contact;  
an electrically-insulative spacer disposed between at least a portion of said first and second contacts, wherein the application of pressure to said first contact establishes electrical communication between said first and second contacts; and  
means for generating an electromagnetic signal in response to said establishment of electrical communication. 30

26. A press-at-any-point switch according to claim 25 further comprising a housing which substantially encloses said contacts. 35

27. A press-at-any-point switch according to claim 26 wherein said housing substantially encloses said generating means. 40

28. A normally-closed electrical switch comprising:  
a plurality of electrically conductive contacts normally arranged in overlapping electrical communication, wherein said contacts are separable in response to an applied pressure which thereby interrupts said electrical communication;  
a signal generator which generates an electromagnetic wave to a location remote 45

from said switch in response to said interruption.

29. A normally-closed switch according to claim 28 wherein said switch comprises at least three of said electrically conductive contacts. 50

30. A normally-closed switch according to claim 28 wherein said contacts are formed of a resilient material. 55

31. A normally-closed switch according to claim 28 wherein said switch further comprises at least one pressure directing element for focusing an applied pressure on at least one of said contacts.

32. A normally-closed switch according to claim 30 comprising a plurality of pressure directing elements and wherein one pressure directing member is aligned for contact with each of said contact. 60

33. A normally-closed switch according to claim 32 further comprising a connector attached to each of said pressure directing elements. 65

34. A normally-closed switch according to claim 28 wherein said switch comprises at least three of said electrically conductive contacts, wherein at least one of said contacts has a body portion and a flexible tongue portion, and wherein said switch further comprises means for rigidly supporting said body portion of said contact such that said flexible portion of said contacts are normally arranged in overlapping electrical communication with said body portion of an adjacent contact. 70

35. A normally-closed switch according to claim 28 wherein said contacts are resilient. 75

36. A normally-closed switch according to claim 28 further comprising a conductive strip disposed in close proximity to said contacts. 80

37. A normally-closed switch according to claim 36 wherein said conductive strip is disposed such that at least one of said contacts touches said conductive strip in response to an applied pressure. 85

FIG. 1

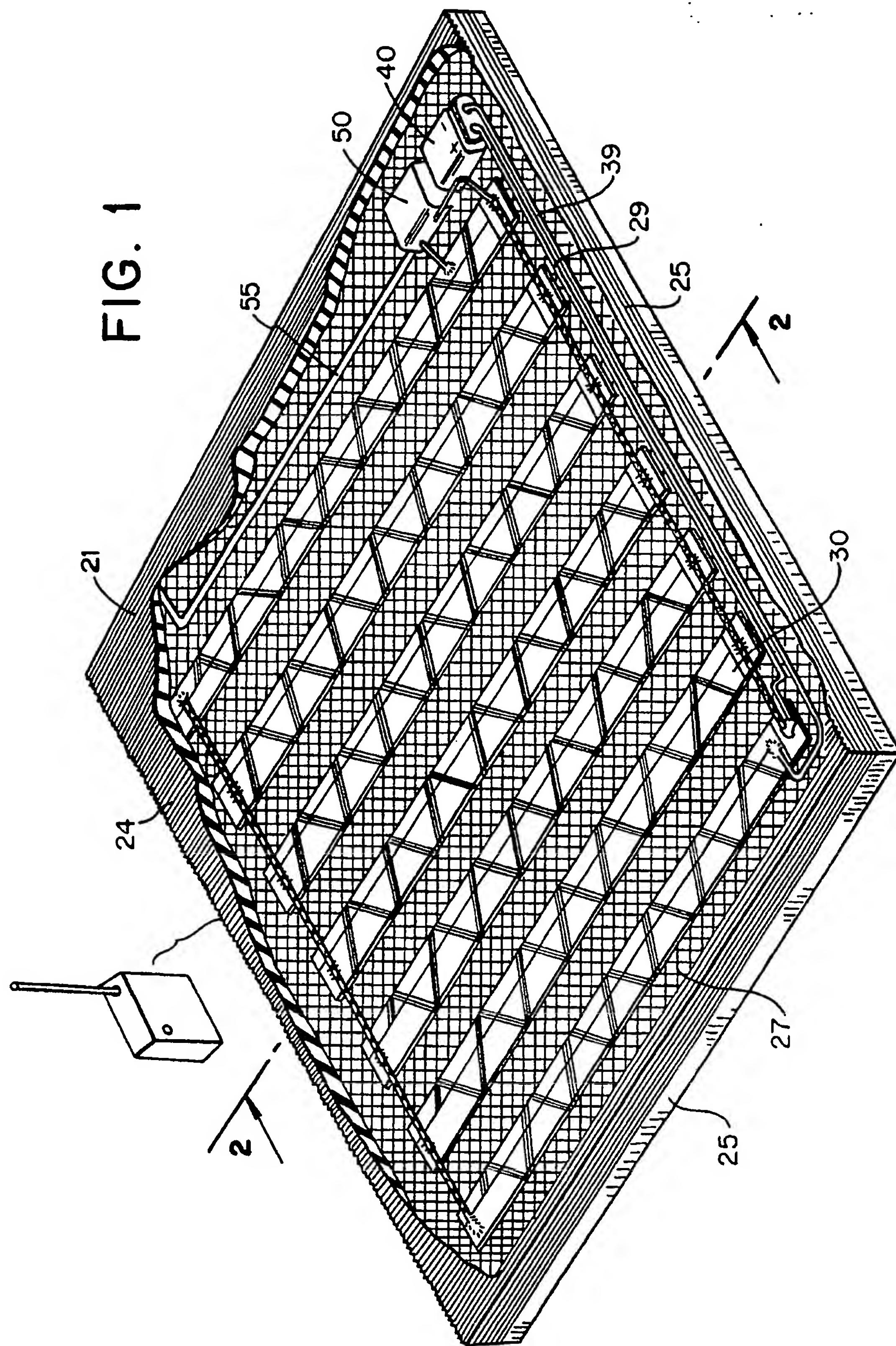


FIG. 2

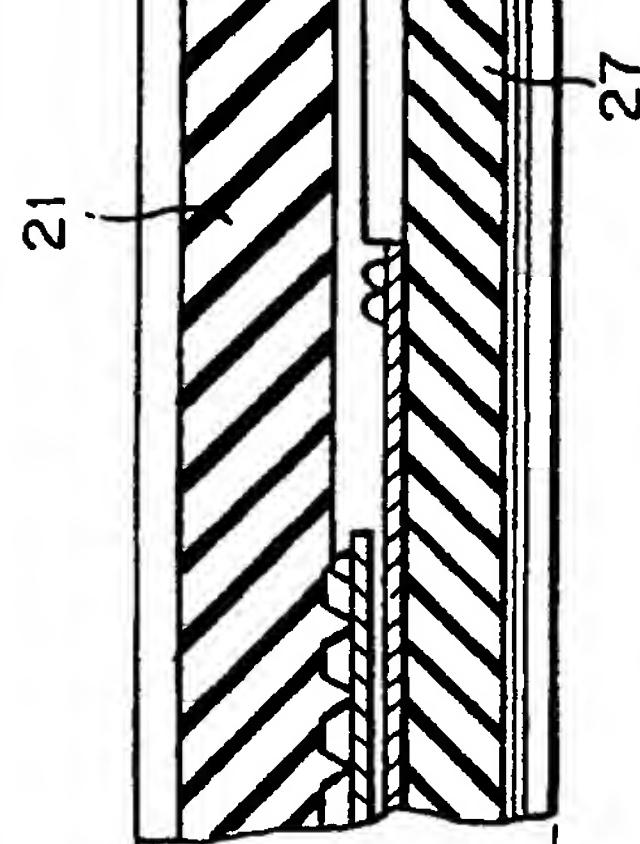
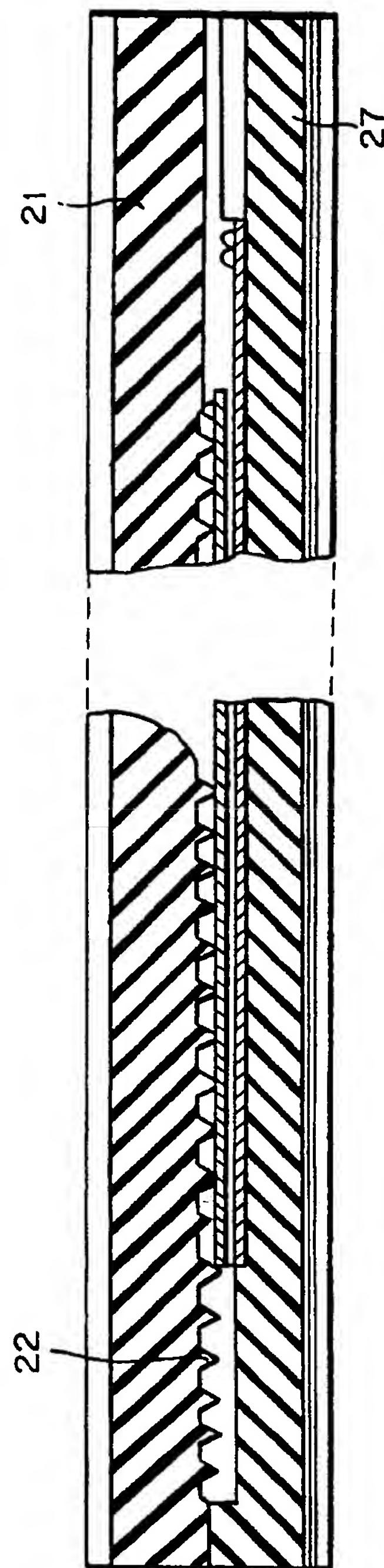


FIG. 3

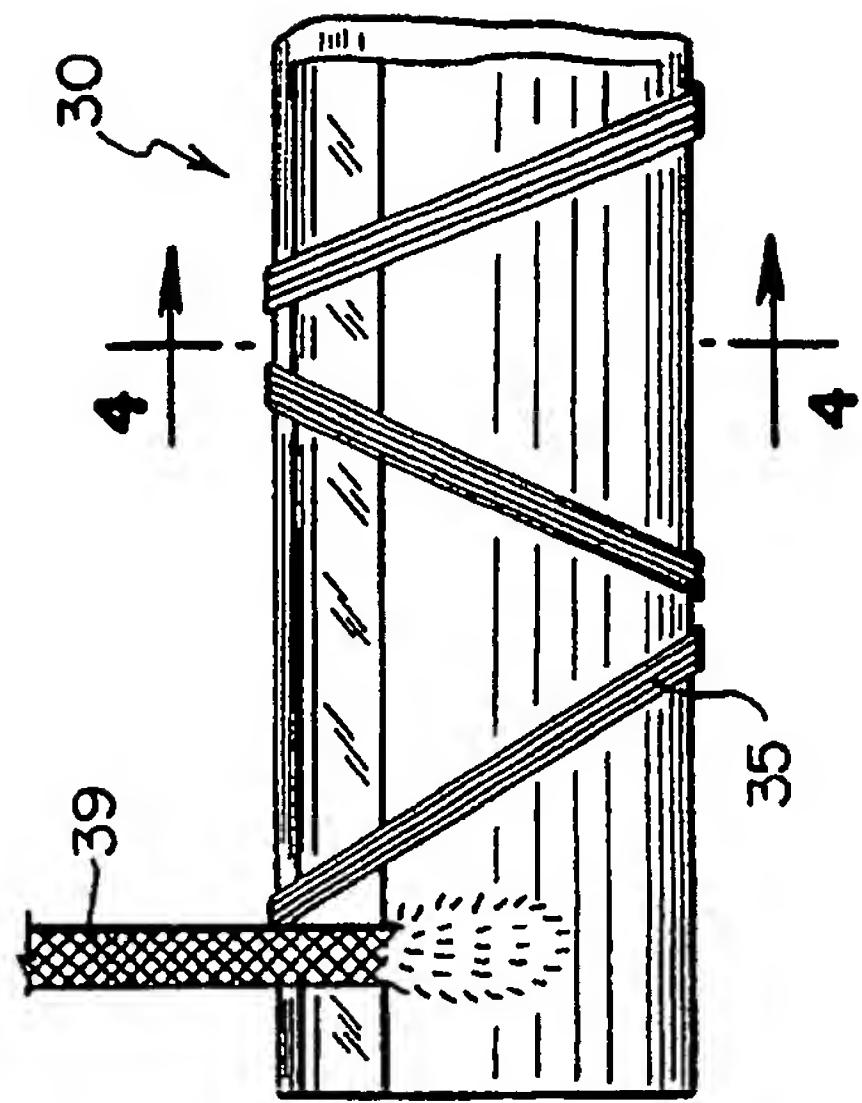
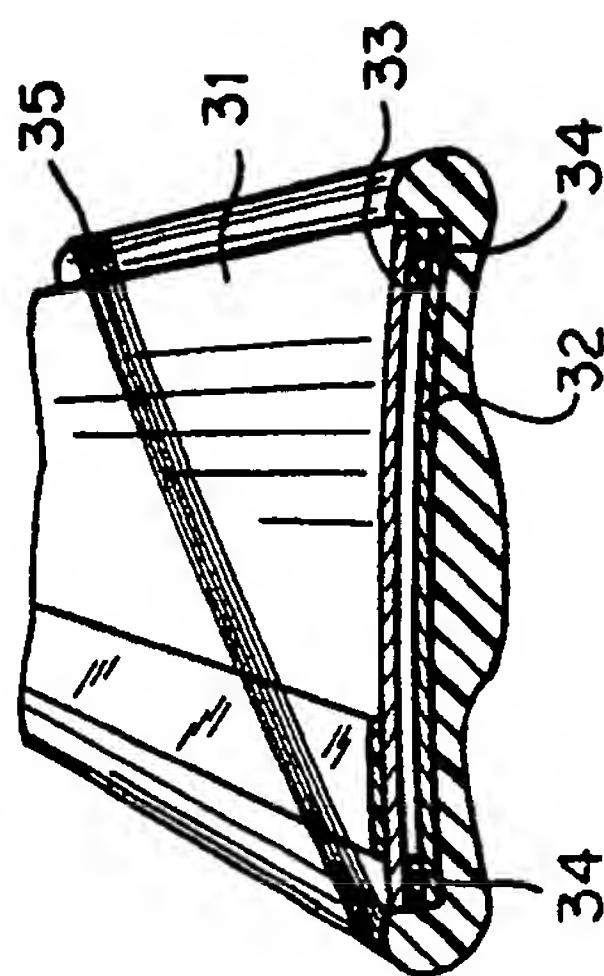
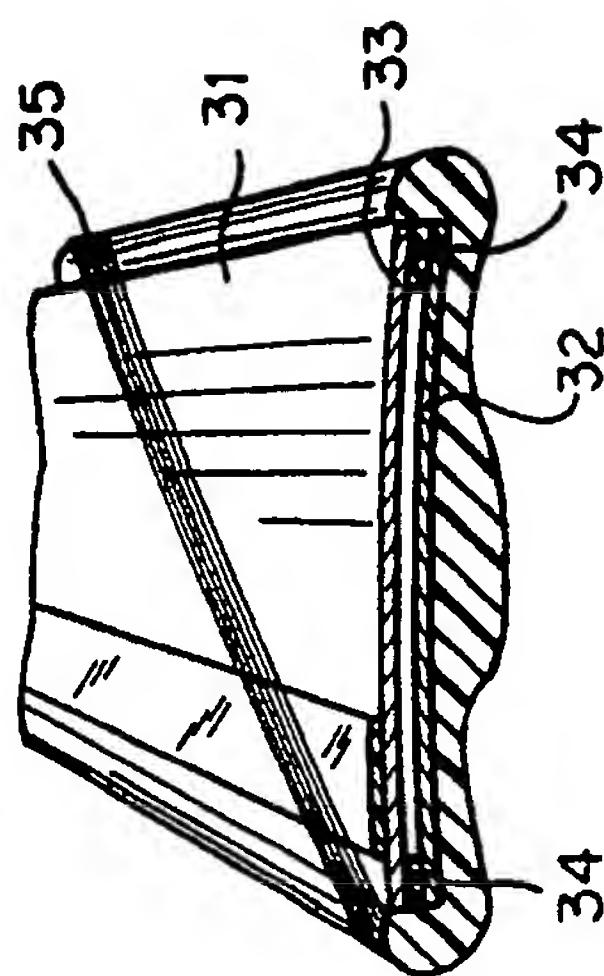


FIG. 4



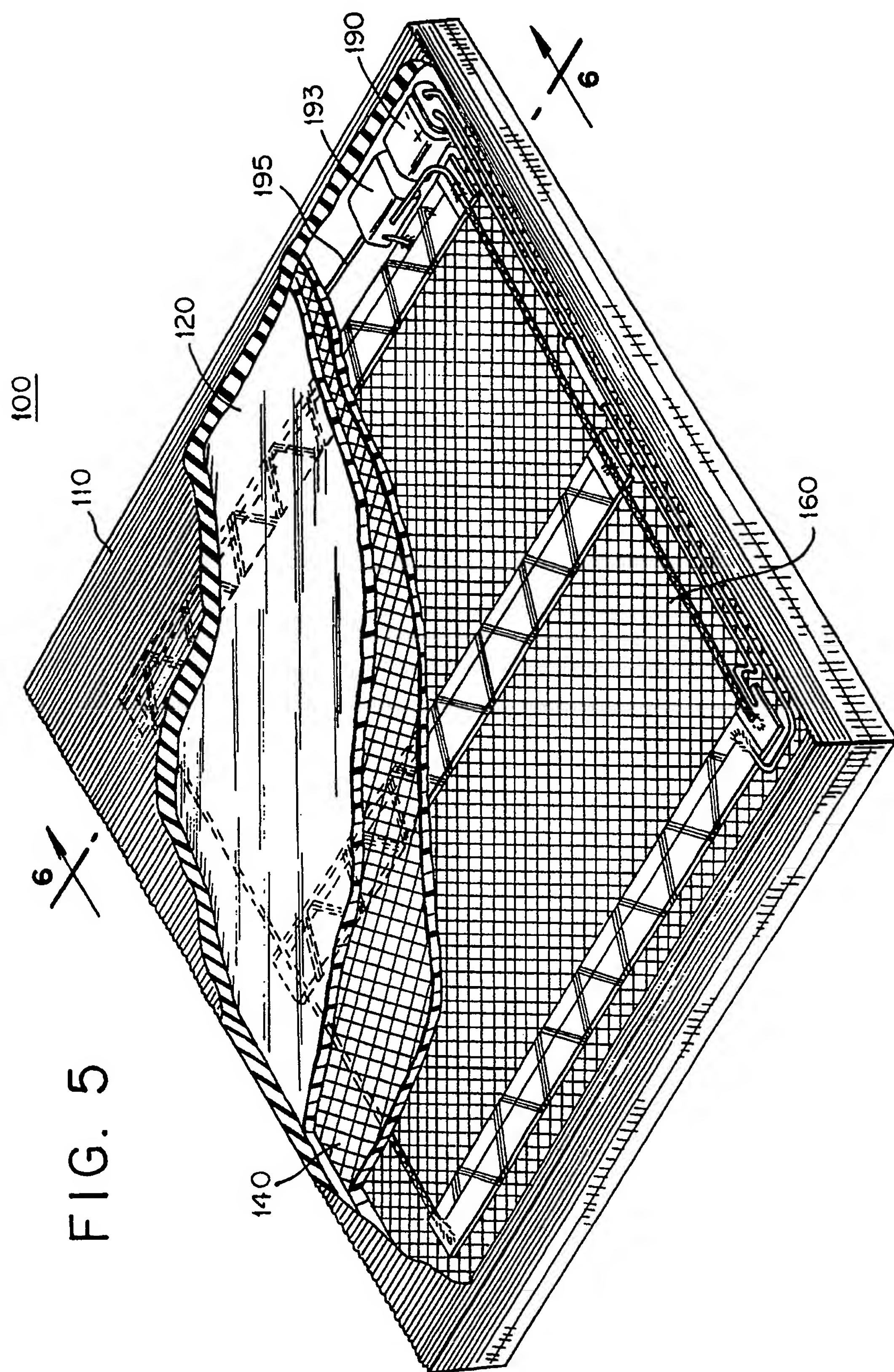


FIG. 6

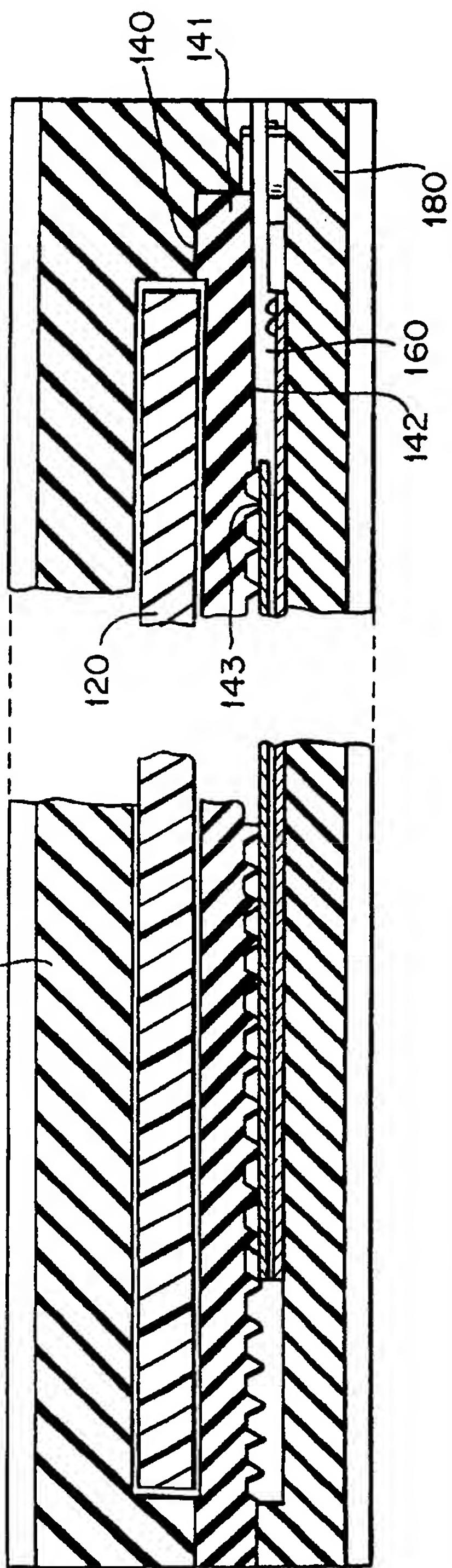


FIG. 7

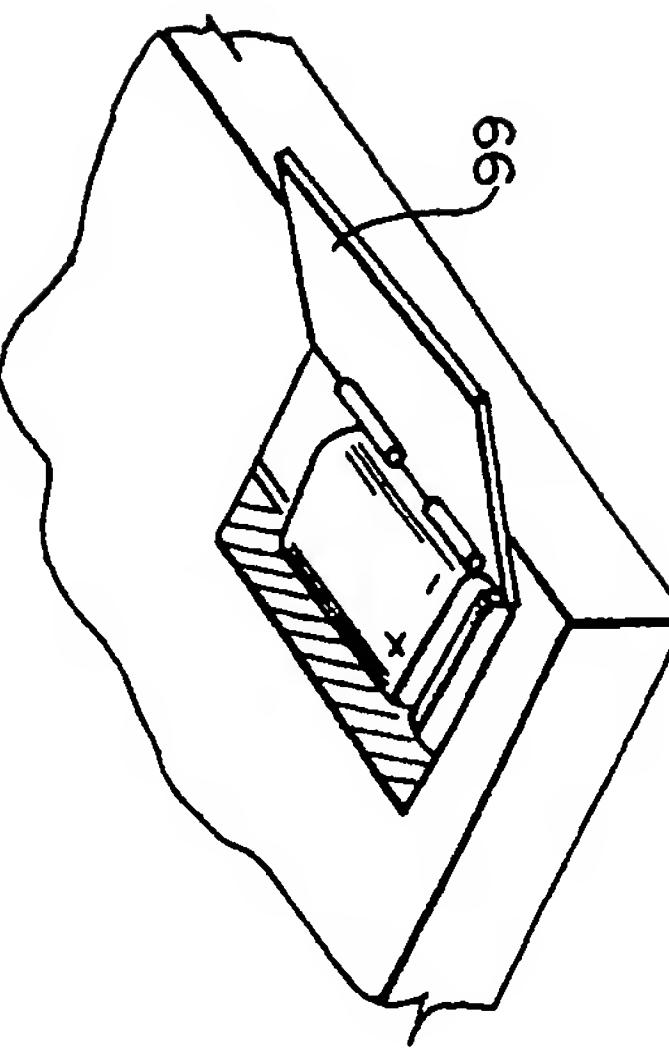


FIG. 8

200

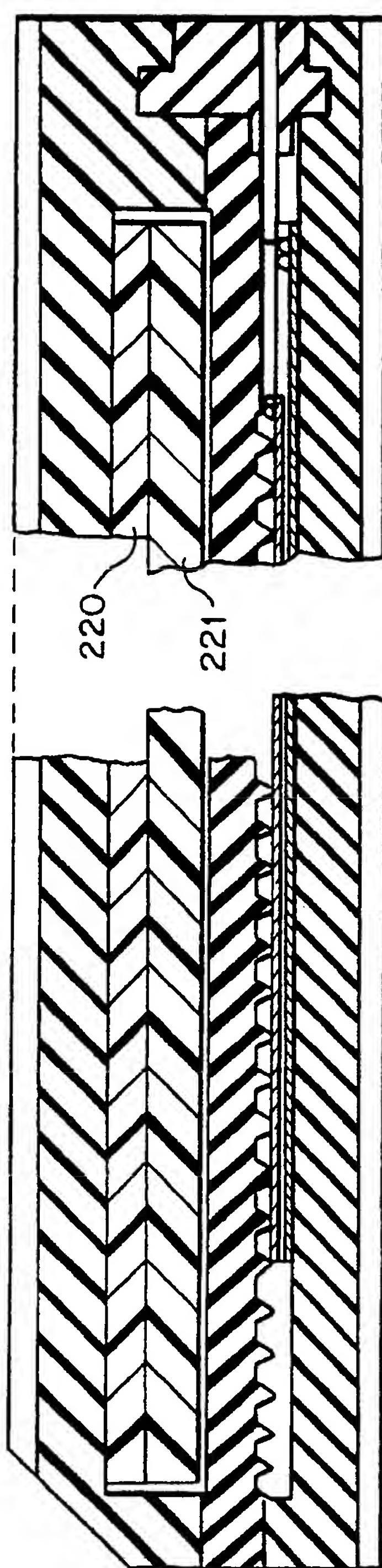


FIG. 9

300

